



EXPLORE SCIENCE

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Director, Mars Sample Return Program

Mars Sample Return (MSR)

Presentation to the Planetary Advisory Committee

November 30th, 2020

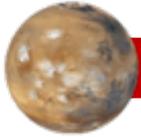


MSR Recent Accomplishments

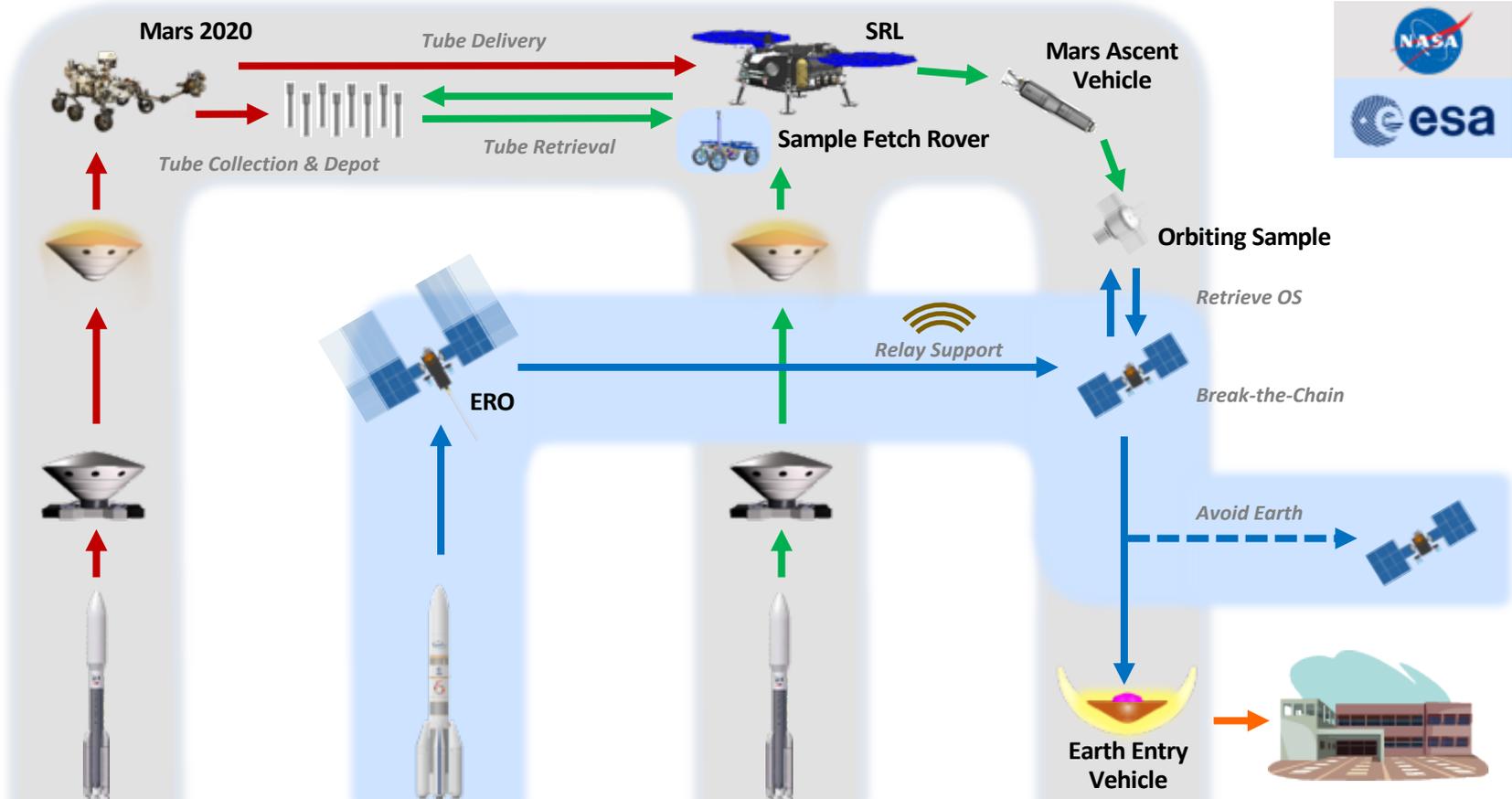
- The MOU establishing the ESA/NASA MSR program partnership was signed by the NASA Administrator and the ESA Director General on October 5th
- IRB Final Report Released 11/10/20
- MCR completed 10/19/20
- SMD DPMC conducted 11/23
- APMC scheduled for 12/16/20

- IRB and SRB both endorsed proceeding into Phase A

MSR Architectural Overview



Mars



Earth

Mars2020

Earth Return Orbiter

Sample Retrieval Lander

Sample Return and Science

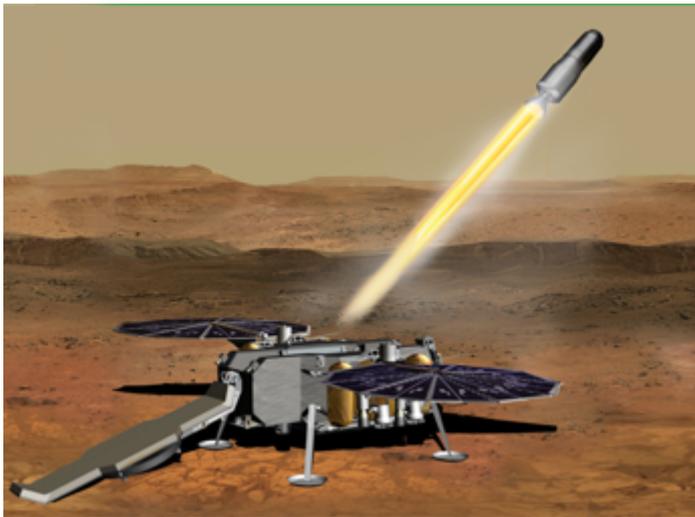
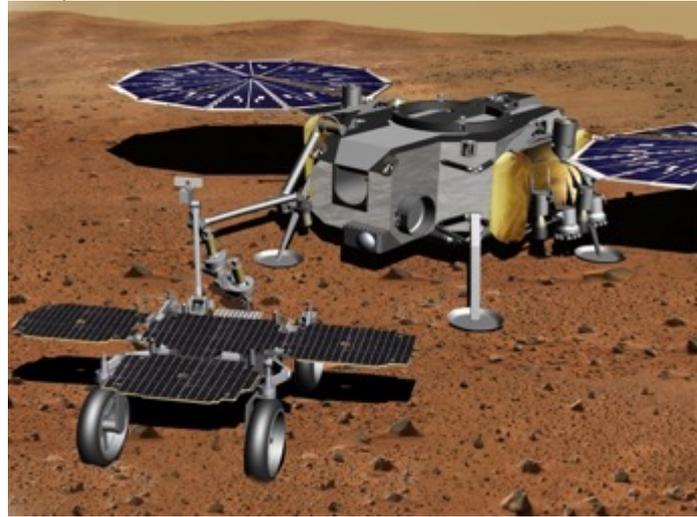
MSR Program Elements



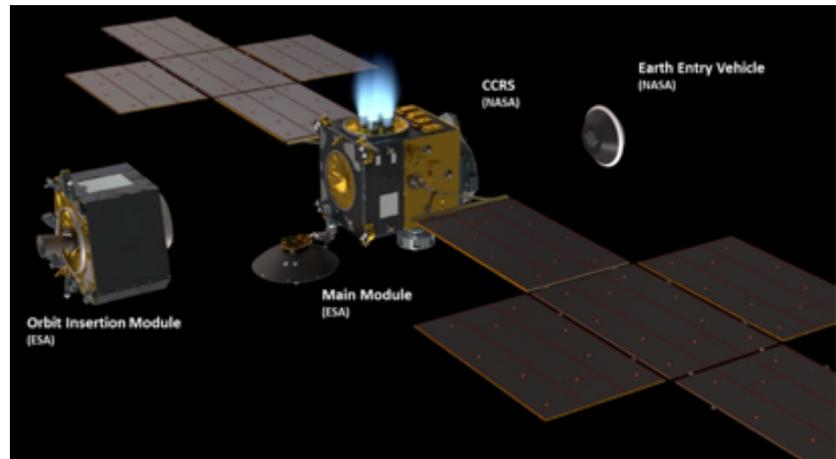
Sample Retrieval Lander (SRL) Touchdown



Sample Transfer



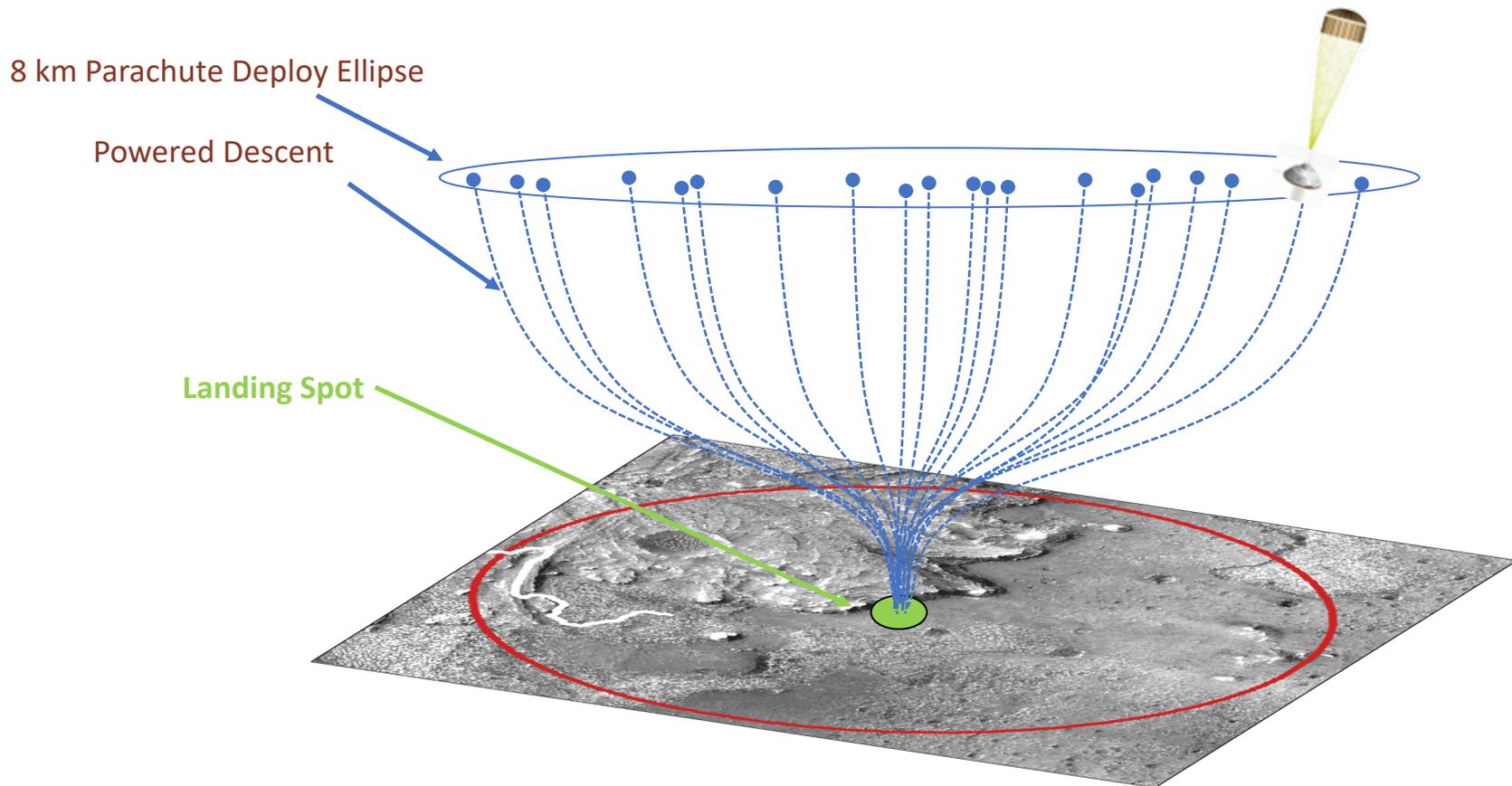
Mars Ascent Vehicle (MAV) Launch



Earth Return Orbiter (ERO)

SRL EDL - Extended Divert

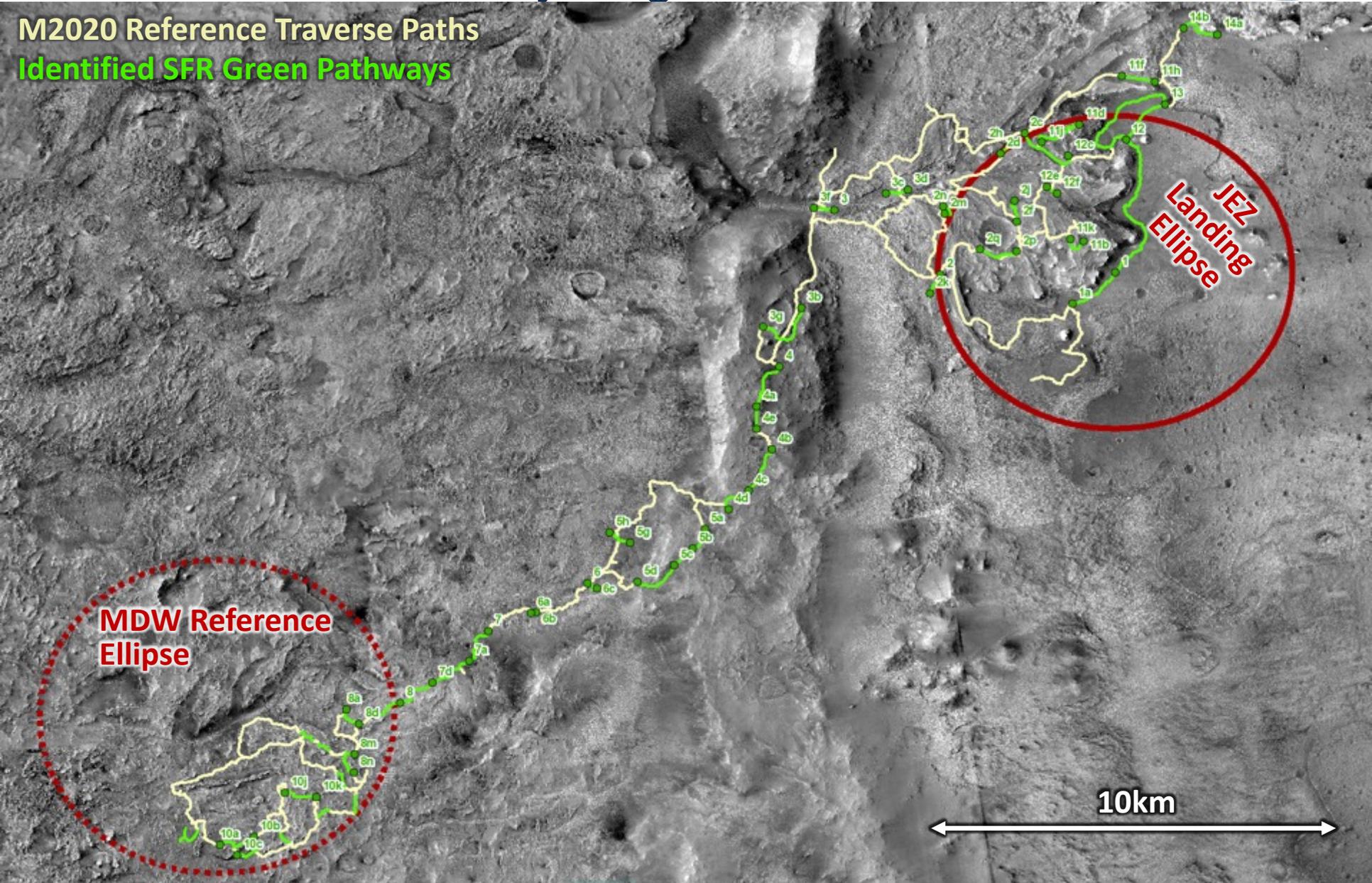
- SRL will carry enough propellant to fly out the backshell separation ellipse (8 x 8 km) and land at a specific spot ($\sim\pm 20\text{m}$ accuracy)
- Enables new capability of landing at a specific site scouted by Mars 2020



Overview of Green Pathways Across Jezero-Midway Region



M2020 Reference Traverse Paths
Identified SFR Green Pathways





Rover Size Comparison

MER



Mass = 173 kg

Number of wheels = 6

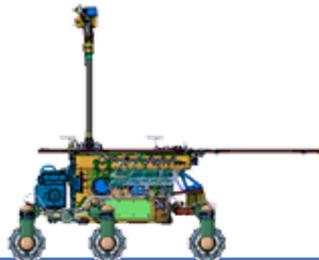
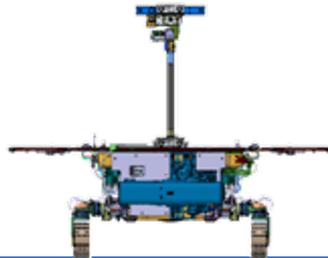
Wheel Diameter = 230 mm

Wheel Type = Rigid

Susp Type = Rocker-Bogie w/
internal diff

Ground Clearance = 300 mm

ExoMars



Mass = 310 kg

Number of wheels = 6

Wheel Diameter = 285 mm

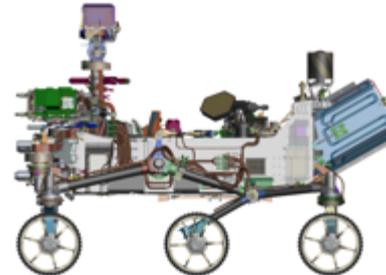
Wheel Type = Compliant

Wheelbase = 1260 mm

Susp Type = 3x Bogie

Ground Clearance = est 250
mm

M2020



Mass = 1030 kg

Number of wheels = 6

Wheel Diameter = 526 mm

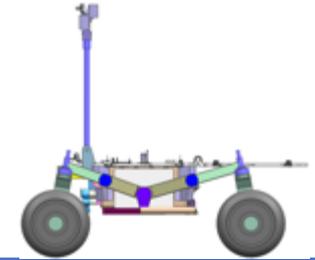
Wheel Type = Rigid

Wheelbase = 2260 mm

Susp Type = Rocker-Bogie w/
external diff

Ground Clearance = 584 mm

SFR



Mass = < 230 kg

Number of wheels = 4

Wheel Diameter = 550 mm

Wheel Type = Compliant, Mesh

Wheelbase = 1550 mm

Susp Type = 4 wheel w/
external diff

Ground Clearance = 350 mm



Resiliency Decisions and Sample Safe States

- Through architecture design, created numerous sample-safe states and decision events
 - Sample(s) are designed to survive on the Mars surface for a minimum of 10 years
 - Functionally redundant paths for delivering samples to SRL (M2020 and SFR)
 - OS orbit is designed to be stable for a minimum of 10 years
 - OS designed to be capable of returning as many as 30 samples
- In Phase A, team will look carefully at each Phase for additional resiliency
- MSR is using resiliency to guide decision making
 - Testing and V&V programs will be detailed with focus on high risk areas
 - Probabilistic risk assessment will be used as part of the SE&I function to quantify risk as part of the Program decision-making process



MSR Launch Opportunities

MSR Launch Opportunity Comparison	ERO		
	2026	2027-28	2029-30
2026	<p>Return: 2031</p> <ul style="list-style-type: none"> Favorable EDL Atmosphere Solar-Only SRL/SFR Heavy SRL Launch Vehicle Relay: ERO & MRN MAS Launch Observed Reference ERO Traj ERO: 5 years M2020: 7 years Backup Does Not Require Redesign 	<p>Primary</p> <p>26/26/31</p>	<p>Return: 2037</p> <ul style="list-style-type: none"> Favorable EDL Atmosphere Solar-Only SRL/SFR Heavy SRL Launch Vehicle Relay: ERO & MRN MAS Launch Observed Reference ERO Traj ERO: 5 years M2020: 7 years Backup Does Not Require Redesign
2028	<p>Return: 2033</p> <ul style="list-style-type: none"> Favorable EDL Atmosphere Solar-Only SRL/SFR Super Heavy SRL Launch Vehicle Relay: ERO & MRN (+2 years) MAS Launch Observed Easier ERO Traj ERO: 7 years M2020: 9 years Backup Requires Redesign 	<p>Return: 2033</p> <ul style="list-style-type: none"> Favorable EDL Atmosphere Solar-Only SRL/SFR Super Heavy SRL Launch Vehicle Relay: ERO & MRN (+2 years) MAS Launch Observed Similar ERO Traj ERO: 6 years M2020: 9 years Backup Requires Redesign 	<p>Return: 2037</p> <ul style="list-style-type: none"> Favorable EDL Atmosphere Solar-Only SRL/SFR Super Heavy SRL Launch Vehicle Relay: MRN (+2 years) MAS Launch NOT Observed More Challenging ERO Traj ERO: 9 years M2020: 9 years Backup Requires Redesign
2030	<p>Return: 2037</p> <ul style="list-style-type: none"> Unfavorable EDL Atmosphere Nuclear SRL/SFR Super Heavy SRL Launch Vehicle Relay: ERO & MRN (+5 years) MAS Launch Observed Similar ERO Traj ERO: 11 years M2020: 12 years Backup Does Not Require Redesign 	<p>Backup</p> <p>28/27/33</p>	<p>Return: 2037</p> <ul style="list-style-type: none"> Favorable EDL Atmosphere Nuclear SRL/SFR Heavy SRL Launch Vehicle Relay: ERO & MRN (+5 years) MAS Launch Observed More Challenging ERO Traj ERO: 9 years M2020: 12 years Backup Does Not Require Redesign



26/26/31 Reference Design
Slightly Worse than 26/26/31
Worse than 26/26/31
Much Worse than 26/26/31

- Each opportunity is evaluated based upon SRL and ERO designed specifically for that opportunity
- MRN = Mars Relay Network
 - MRO, MAVEN, TGO
- Nomenclature: "28/27/33"
 - SRL Launches in 2028
 - ERO Launches in 2027
 - ERO Returns in 2033
- "2027-28" covers the potential for ERO to launch one year earlier and use an Earth flyby prior to utilizing a 2028 Earth - Mars transfer. These options are architecturally similar.

Science Integration Across Programs

- Science is working closely with system engineers on requirements and essential trade-offs.
- NASA/ESA Mars Sample Return Sample Planning Group – Phase 2 (MSPG2) is addressing science and curation planning questions for analyzing returned samples, developing draft requirements for the Sample Receiving Facility.
 - Terms of Reference signed in April 2020, reports expected in Spring 2021
- COSPAR Sample Safety Assessment Protocol Working Group (SSAP) is developing a recommendation for determining when extraterrestrial samples are safe for distribution outside of containment.
 - Report out in Jan/Feb 2021 at COSPAR Assembly
 - NASA interests are represented through Planetary Protection, Mars Science, and US scientists
- An open community workshop for a Perseverance/MSR Sample Caching Strategy Workshop planned Jan. 2021, informing the draft operations M2020/MSR MOU



Going Forward- Phase A

- Complete Architectural Trade Studies recommended by IRB
- Continue Technology and Engineering Development plans
- Continue to work Planetary Protection requirements
- Proceed with NEPA process
- Work to ensure MSR coordination with M2020 Phase E sampling operations
- Work to maintain 2026 schedule through PDR, per IRB and SRB recommendations



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